A Note on the Locational Determinants of the Agricultural Supply Chain

by

Anders Van Sandt
University of Wyoming

Craig Wesley Carpenter
Texas A&M University

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Abstract

Over the past several decades, an increasing share of the agricultural supply chain is located beyond the farmgate, implying that some set of economic factors are influencing the location decisions of food and agricultural establishments. We explore the location decisions of several food and agricultural industries for employer and non-employer establishments by expanding on the empirical implications of Carpenter et al. (2021)'s demand threshold models. While Carpenter et al. (2021) focus on methods to estimate these industries' demand thresholds using restricted access data, we focus on expanding the interpretations of their empirical research and explore additional industries along the agricultural supply chain using their refined methods. Results highlight the influential role of the Land Grant University system for specific establishment types, the importance of diverse industries within local economies, and the changing rurality of the agricultural supply chain.

Keyword*:* Agriculture, supply chain, demand threshold, location decisions, non-employers

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[*] DISCLAIMER:
Any opinions and conclusions expressed herein are those of the author(s) and do not necessarily represent the views of the U.S. Census Bureau. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 1835. All results have been reviewed to ensure that no confidential information is disclosed.

Introduction

Agriculture remains a central component to many rural US economies, yet over the past several decades a growing share of the agricultural supply chain has moved off the farm. This shift suggests that the location decision of many food and agricultural industries (FAI) is no longer solely tied to the point of agricultural production and that another set of economic and place-based factors are determining FAI location decisions. At the same time, the agricultural supply chain faces consumer health and food contamination concerns, changing consumer preferences toward food and agriculture, and changing global trade patterns. One challenge for rural economies is to identify what these locational determinants influence FAI establishments along the agricultural supply chain in order to foster economic growth and to retain value in rural communities.

Demand threshold models are frequently used in the regional development literature to determine the minimum population threshold necessary to sustain various types of retail or service industries. These models are born out of Christaller's (1966) Central Place Theory, which postulates that the spatial radius of a market is defined by the demand as well as the cost of supplying the good or service. Much of this literature revolves around how location specific economic and physical characteristics influence the location decisions of establishments within the retail, manufacturing, and service industries (Chakraborty, 2012; Henderson et al., 2000; Reum & Harris, 2006). Recently Carpenter et al. (2021) updated this vein of literature by using restricted-access establishment data to identify the data generation processes of different FAI depending on the sector, the size measure used (i.e. employer establishments, non-employer establishments, and employment), and the level of industry aggregation used.

This article explores the applied interpretations of Carpenter et al.'s (2021) empirical research by delving into what locational determinants influence the location decisions of non-production employer and non-employer establishments along the agricultural supply chain. Specifically, we expand Carpenter et al. (2021)'s specified demand threshold models of FAI establishments to include several other finely disaggregated FAI using restricted-access data and interpret unexplored aspects of their research. Understanding the factors that influence FAI location decisions is essential in improving the design and operation of the agricultural supply chain.

After reviewing past analyses of locational determinants and summarizing Carpenter et al. (2021)'s methods, we build a narrative by comparing the marginal effects of several locational variables across different employer and non-employer FAIs. Expanding on the interpretations of Carpenter et al. (2021)'s demand threshold models for FAI reveals several influential locational determinants for the evolving agricultural supply chain including the influential role of the Land Grant University system, the importance of diverse industries within local economies, and the changing rurality of the agricultural supply chain.

Literature Review

Central place theory (CPT) posits that larger peripheral areas provide lower-ordered goods and services while central places will host far-reaching, higher-ordered goods and services as well as all other lower orders. While establishments offering lower-ordered goods and services, which

are relatively inexpensive and are purchased frequently may remain viable in a smaller market, higher-ordered goods and services may serve larger regional markets. Demand threshold models apply CPT to predict the minimum population threshold necessary to support an establishment, but as the literature has shown, this population threshold is heavily influenced by other place-based factors such as economies of agglomeration, transportation infrastructure, and other locational specific characteristics. Just as with other service industries, CPT may be used to describe the location decisions of FAI, whose locations are likely determined by the FAI's hierarchical rank within the agricultural supply chain as well as other place-based factors, including agricultural production, internet access, Land Grant universities, and social capital. In addition, demand threshold analysis is used by state extension programmers to evaluate the viability of local retail and service establishments, illustrating the potential benefits of using CPT to further industry and community economic development efforts (Deller & Ryan, 1996).

Mulligan, Partridge, and Carruthers (2012) present some of the key advantages and critiques of using CPT to explain spatial patterns of economic activity, and ultimately argue for its reemergence using micro data on establishment location decisions. While we do not argue that CPT is superior to other frameworks such as the New Economic Geography (Krugman, 1991), or locational choice analysis (e.g. Carlton, 1983; Carpenter, Dudensing, et al., 2021; Carpenter, Van Sandt, et al., 2021; Conroy et al., 2016; Van Sandt, Carpenter, & Tolbert, 2021; Van Sandt, Carpenter, Dudensing, et al., 2021), the empirical flexibility of CPT make it ideal to evaluate the location decisions of FAI along the agricultural supply chain. In addition, Carpenter et al. Carpenter, Van Sandt, and Loveridge (2021a) point out that the econometric methods of locational choice analysis are compatible with those of demand threshold analysis (Guimarães et al., 2003, 2004).

Amongst other core regional concepts, applying CPT to examine the agricultural supply chain will shed light on economies of agglomeration, consumer choice, and a functional hierarchy across different FAI. Some FAI may derive benefits from agglomerating near similar industries in the same sector, or by industries in related sectors like manufacturing, wholesale, and transportation and warehousing. In addition, just as with other service industries, FAI must strike a balance between locating near agricultural inputs and downstream links in the supply chain to minimize costs and maximize market accessibility. Finally, exploring different types of establishments (i.e. employers and non-employers) within industries may reveal part of the hierarchical structure of FAI. For example, non-employers may serve smaller, peripheral markets in the hinterlands, while larger employer establishments locate in central places.

While no one has explicitly sought to explore the location decisions of FAI using demand thresholds in the past, some studies have inadvertently examined some of these industries while concentrating on either retail or manufacturing establishments. For example, Reum and Harris (2006) find that food manufacturing establishments locate near other manufacturing employment, suggesting benefits from agglomeration, as well as near airports, most likely suggesting decreased transportation costs and greater access to larger markets. In a retail-centric demand threshold analysis, Chakraborty (2012) finds that building material and garden supply establishments are

more attracted to metro counties, revealing a higher ordered position in the functional hierarchy.[1] In addition to the limited knowledge on FAI location decisions, no past studies simultaneously account for overdispersion and zero-inflation in the data, and they frequently use limited geographic scopes and suppressed data to estimate demand thresholds. We address these limitations in the following section.

Methods

The primary objective of Carpenter et al. (2021)'s article is to identify the data generation processes of three industry size measures across different levels of aggregation within FAI. We only summarize their estimation process here while directing more interested readers to their complete development of model specification. Carpenter et al. (2021) outline how over dispersion and zero-inflation reveal insight into the decision-making process of locating an FAI establishment in a particular county. They demonstrate how industry aggregation increases the likelihood of misinterpreting these specific features of the data and argue misidentifying the underlying data-generation process leads to biased estimates of location determinants in demand threshold modeling.

Carpenter et al. (2021) begin by first testing for overdispersion in the data which may lead to an increase in type one errors in hypothesis testing if the data are modeled as a Poisson distribution rather than the more flexible negative binomial. Next, they hypothesize that not all counties with zero establishments within an industry are the same. Some "zero-counties" are structural-zeros and contain no establishments due to a lack of some essential characteristic, like agricultural production, while others are sampling-zeros where economic factors prevent establishments from locating in a feasible county. We stay consistent with Carpenter et al. (2021) and test between the standard count data model and zero-inflated model which includes a logit link function by visual inspections histograms and the Akaike and Bayesian information criterion. The log likelihood function of the zero-inflated Poisson may be written:

$$LL = \sum_{t,i=1}^{n} I_{y_{it}=0} \log\left[e^{z_{it}\gamma} + e^{-e^{x_{it}\beta}}\right] + \sum_{t,i=1}^{n} I_{y_{it}\neq 0}\left[y_{it}x_{it}\beta - e^{x_{it}\beta} - \log(y_{it}!)\right] - \sum_{t,i=1}^{n} \log[1 + e^{z_{it}\gamma}]$$

where is a vector of covariates defining the probability of the zero-generating source, and is a vector of covariates defining the count. and may share covariates. The zero-inflated negative binomial takes on a more generalizable form by including an additional parameter to allow the conditional mean to be different from the conditional variance. As this overdispersion parameter goes to zero, the zero-inflated negative binomial collapses to the zero-inflated Poisson. Table one summarizes the distributional findings across ten different FAI.

As in Carpenter et al. (2021), we use 2014 county-aggregated establishment-level data accessed through the Federal Statistical Research Data Center (FSRDC) system. Carpenter, Van Sandt, and Loveridge (2021b) show this is valuable, even with aggregated county-level data. Employer establishment data are drawn from active establishments within the Longitudinal

[1] Higher order establishments are commonly associated with goods/services that have larger spatial radiuses, are relatively expensive, or are purchased relatively infrequently.

Business Database, and the non-employer establishment data are drawn from the Integrated Longitudinal Business Database, both of which are products of the Business Register (BR/SSEL). This data includes all establishments in the contiguous US regardless of rurality, highlighting the usefulness

Table 1. Distributions of FAI Across Industry Measures

Industry (NAICS code)	Non-Employer Establishments	Employer Establishments
Support Activities for Crop Production (1151) *Examples: soil preparation, harvesting, management*	NB	ZINB
Support Activities for Animal Production (1152) *Examples: breeding, testing, reproduction services*	NB	ZINB
Fruit and Vegetable Preserving and Specialty Food Manufacturing (3114) *Examples: freezing, canning, pickling, drying*	ZINB	ZINB
Animal Slaughtering and Processing (3116) *Examples: all products produced in slaughtering plants*	ZINB	ZINB
Fresh Fruit and Vegetable Merchant Wholesalers (424480) *Examples: fresh berries, fruit, vegetables, health foods*	*	ZINB
Farm and garden Machinery and Equipment Merchant Wholesalers (423820) *Examples: harvesting, irrigation, conveying, milking*	*	ZINB
Farm Supplies Merchant Wholesalers (42491) *Examples: chemicals, fertilizers, feed, containers, straw*	ZINB	ZINB
Nursery, Garden Center, and Farm Supply Stores (444220) Examples: feed stores, farm supply stores, nurseries	*	NB

*No non-employer establishments are reported in the restricted access data for the disaggregated industries under Crop Support Services (11511). This is likely due to non-employers partaking in multiple business activities within Crop Support Services and the Census' desire to avoid misclassifying establishments.

of the estimated parameters for agricultural marketing and rural economic development researchers and practitioners.

The set of independent variables included in the model specifications primarily differ from one another depending on whether the FAI is crop or animal centric. For example, the covariates for Support Services for Crop Production include crop production variables and no animal production variables, while Support Services for Animal Production has animal and no crop production variables. While not reported, all regressions contain regional fixed effects based on the USDA's 12 agricultural regions. Due to strong disclosure rules surrounding agricultural production intensity measures, and not having access to more complete restricted-access data for agricultural production, we use the count of farms and ranches in a county to capture agricultural

production activity. Summary statistics for these agricultural production variables are available in the appendix.

Results and Discussion

Before turning to interpreting the locational determinants of FAI establishments by comparing the marginal effects of several key sets of model coefficients, we first draw attention to the summary statistics of FAI establishments in table 2. While these statistics are computed from public data sources, and not the restricted-access data used for the analysis, they illustrate the prevalence of non-employer establishments in FAIs. Non-employer establishments exist in more counties than their employer counterparts for Support Activities for Crop (1151) and Animal Production (1152) as well as Fruit and Vegetable Preserving and Specialty Food Manufacturing (3114). In fact, nationally, these first two industries are characterized by more non-employer establishments than employer establishments showing the prevalence and importance of non-employer establishments in FAI, particularly in the agricultural sector. These comparisons between industry size counts begin to reveal some of the differences between the location decisions of non-employers and employers in FAI.

We now turn to interpreting some of the location decision variables for eight employer FAI establishments and five non-employer FAI establishments. Unsurprisingly, agricultural production is one of the best indicators of FAI establishments locating in a county. Summary statistics of agricultural production are presented in table A.1 in the appendix. The negative agricultural production coefficients in the inflation stages of industries with zero-inflation are interpreted as the reduced probability of counties with these types of agricultural production belonging to the certainly zero group.[2] The positive and significant coefficients for the metro dummy in both Support Services for Crop (1151) and Animal Production (1152), further establish these two FAI as being primarily rural activities that locate near agricultural production. However, differences emerge between these two industries when considering the marginal effects of agricultural

Table 2. Food and Agricultural Industry Summary Statistics

NAICS	Metric	Counties	Mean	Std. Dev.	Max
Support Activities for Crop Production (1151)	Non-emp. Establishments	2,989	16.12	30.73	936
	Establishments	1,506	3.10	5.55	99
	Employment	1,506	22.79	169.82	4,039
Support Activities for Animal Production (1152)	Non-emp. Establishments	2,949	13.40	23.28	380
	Establishments	1,252	3.46	6.07	85
	Employment	1,252	5.70	25.39	379
Fruit and Vegetable Preserving and Specialty Food Manufacturing (3114)	Non-emp. Establishments	1,098	1.99	7.25	130
	Establishments	700	2.62	4.04	68
	Employment	700	75.27	352.51	4,650
	Non-emp. Establishments	1,338	0.41	1.70	22

[2] Note, this interpretation is opposite that of hurdle models (e.g. Heckman two-stage), since we are first modeling the zero structure of the dependent variables, not the existence of a positive count.

Animal Slaughtering and Processing (3116)	Establishments	1,561	2.32	3.40	77
	Employment	1,561	64.05	450.78	7,706
Fresh Fruit and Vegetable Merchant Wholesalers (42448)	Non-emp. Establishments	(N/A)	(N/A)	(N/A)	(N/A)
	Establishments	735	6.56	20.58	401
	Employment	735	107.61	421.27	7,660
Farm and garden Machinery and Equipment Merchant Wholesalers (42382)	Non-emp. Establishments	(N/A)	(N/A)	(N/A)	(N/A)
	Establishments	2,108	3.64	4.01	57
	Employment	2,108	28.43	67.74	1,044
Farm Supplies Merchant Wholesalers (42491)	Non-emp. Establishments	1,419	0.50	2.06	36
	Establishments	2,063	4.13	4.85	59
	Employment	2,063	22.05	67.85	1,139
Nursery, Garden Center, and Farm Supply Stores (44422)	Non-emp. Establishments	(N/A)	(N/A)	(N/A)	(N/A)
	Establishments	2,599	5.32	7.74	172
	Employment	2,599	30.11	74.75	1,187

These statistics are based off the publicly available County Business Patterns and Non-Employer Statistics data. Non-employer statistics are not available for three of the industries in both the public and restricted access data sources, suggesting that there are an insignificant number of non-employers in these industry classifications, presumably due to the nature of these industries.

production variables between employers and non-employers in the amount stages of the models. The number of farms and ranches in a county has a much larger draw for non-employer both crop and animal support services, indicating a desire for tighter or more proximate supply chains for non-employers. Unlike the two agricultural support services, the marginal effects for manufacturing and wholesaling FAI with available non-employer data, reveal that more agricultural production has a larger effect on employer establishments rather than non-employer establishments.

Table 3 presents some of the highlights of the marginal effects from the amount stages. The full regressions are available in table A.2 in the appendix. As consumer preferences change, an increasing share of agricultural producers have adopted additional economic activities like direct to consumer or retailer sales, agritourism, and value-added goods. In general, areas with these local food systems have more agricultural support services, fruit and vegetable manufacturers, farm supply wholesalers, and farm supply stores. This provides evidence that in addition to bringing some services like distribution back to the farm (e.g. direct sales), local foods systems also create more opportunities for more establishments in some industries along the agricultural supply chain to locate in the local economy. There seem to be particular advantages for non-employer establishments in agricultural support services (1151 & 1152). For example, on average, counties with 100 local foods farms (the average among the 2,557 counties with local foods) have three additional non-employers in Support Services for Crop Production (1151) and one non-employer in Support Services for Animal Production (1152) compared to counties without local foods farms, ceteris paribus.

Internet access, measured as the number of internet service providers in the county, does not appear to significantly influence the location decisions of FAI establishments. Since we control for metro areas and population, this may be due to business owners relying more on wireless internet access or simply a signal that internet access is not an important locational determinant

for FAI. Social capital, measured by Rupasingha, Goetz, and Freshwater's (2006) index, appears to be a more significant driver in FAI establishments' location decisions.[3] An increase in one standard deviation above the mean is associated with over two additional non-employer crop support services (1151) establishments, and similar effects are present in at least one industry in each of the four sectors examined. On average, Land Grant universities lead to seven additional non-employer and almost one additional employer establishments in animal support services (1152). While we are unsure of what direct effect from Land Grants is specifically boosting this industry and no others, it is clear that Land Grants are important place-based factors in animal support services location decisions.

The coefficients of the two rurality dummy variables do not paint a uniform picture of rural industries, but a couple patterns emerge from the estimated marginal effects. First, marginally fewer establishments in industries up-stream of agricultural production (i.e. Farm Equipment Wholesalers (42382), Farm Supplies Wholesalers (42491), and Nursery and Farm Supply Stores (44422)) locate in metro areas, indicating a slight, but statistically significant preference to be closer to output markets or to locate in areas where land may be cheaper. Second, although statistically significant in multiple industries, it appears that rurality does not play an economically meaningful role in determining FAI location decisions. Although, considering we control, for per capita income, median home value, population, and population density, these variables are likely only capturing the agglomeration benefits from being located in a city.

The location quotients for three different sectors were included in each of the models to account for interindustry economies of agglomeration.[4] Benefits from locating in areas with relatively higher shares of local employment in either the manufacturing or wholesale sectors are higher for employer establishments rather than non-employer establishments. Although not large,

[3] All models use the 2014 update of Rupasingha et al.'s (2006) social capital index for estimation.

[4] Location quotients (LQ) are defined as the share of employment in an industry in a county relative to the total employment in the county, divided by the share of employment in an industry in the US relative to the total employment in the US. When calculating the LQ for an industry's greater sector, the industry's employment was omitted from the LQ calculation to prevent endogeneity issues.

Table 3. Marginal Effects of Amount Stage Covariates

	Crop Support (1151)		Animal Support (1152)		Fruit & Vegetable Manufacturing (3114)		Animal Processing and Slaughtering (3116)		F&V Wholesale (42448)	Equip. Wholesale (42382)	Farm Supply Wholesalers (42491)		Nursery/ Farm Supply Stores (44422)
Establishment Type	Non-Emp.	Emp.	Non-Emp.	Emp.	Non-Emp.	Emp.	Non-Emp.	Emp.	Emp.	Emp.	Non-Emp.	Emp.	Emp.
Local Foods Farms	3.681***	0.2095	1.136*	0.3317***	0.203***	0.029*	0.1215	-0.0555*	0.0205	-0.0202	0.0356*	0.1124**	0.3599***
ISP Count	-0.3544	0.2265*	-0.7966*	0.01	-0.0356	0.0307	0.0207	0.0127	-0.0578	0.001	0.0327	0.1656***	-0.066
Social Capital	1.762**	0.7114***	0.6186	0.0909	-0.0255	0.0192	0.0445**	0.2147***	0.3755***	0.3052***	-0.0447	0.2279***	0.3412***
Land Grant	0.998	0.2201	7.402*	0.6114*	-0.0268	-0.1097	(D)	-0.3027**	-0.3695	0.136	0.1033	-0.028	-0.2995
Railroad Est.	-1.907	1.691	0.7667	-0.1334	0.0236	0.0801	0.0248	0.1258*	0.0656	0.1674*	-0.0118	0.3622	0.1163
Truck Emp.	0.0723	0.025*	-0.0508	-0.0045	0.0047	0.0012	0.0087***	0.0089***	0.003	0.0009	0.004***	0.012**	0.0025
Air Freight Est.	0.8998	-1.014*	5.987	0.4049	0.0074	0.0155	-0.0117	-0.0184	0.1248	0.1764*	0.0879*	0.1255	0.0816
Metro Adjacent	-1.012	0.4078	0.486	0.1526	-0.3067*	-0.0002	(D)	0.0254	-0.3049	0.068	-0.0742	-0.2274*	0.1336
Metro	-3.209**	-0.0294	0.0305	0.5105**	-0.5666***	-0.1123	-0.1025	-0.0866	-0.0749	-0.3624***	-0.1479*	-0.4156**	-0.6708***
LQ Manuf.	0.5293**	-0.1203	0.2597	0.1137***	-0.0274	0.0702*	0.0511***	0.1755***	-0.1288*	0.0988***	0.0213	0.1093***	0.155***
LQ Wholesale	3.941***	0.8099***	0.2799	0.0929	-0.0318	0.0983***	0.0001	0.054**	0.8404***	0.5598***	0.0518**	0.5503***	0.2482***
LQ Trans. & Warehousing	-0.5843*	-0.3121**	-0.1207	0.0132	-0.084*	0.0334	0.0033	-0.0159	0.0154	0.0114	-0.0112	-0.0439	0.071

Significance levels: ***<1%, **<5%, *<10%, (D) cell did not meet disclosure requirements
Full regression results available in appendix.
Local Foods Farms measured as 100's of farms per county. Railroad Est. and Air Freight Est. measured as 10's of establishments per county. Truck Emp. Measured as 100's of employees per county.

there are benefits from manufacturing and wholesale FAI agglomerating near other manufacturing and wholesale establishments.

Concluding Remarks

While Carpenter et al. (2021) focus on identifying the data-generation processes of different FAI industries, and glean information about the business owner's decision-making process from these distributions, they leave the marginal effects of their models largely unexplored. Motivated by the changing structure of the agricultural supply chain and shift to more agricultural activities being conducted beyond the farm gate, we offer unexplored interpretations of Carpenter et al.'s empirical research. Specifically, we use restricted-access data to estimate demand threshold models and interpret the marginal effects of several location determinants.

While agricultural production is still the dominant determinant of FAI establishment counts, some place-based factors are economically significant drivers for FAI location decisions. For example, the presence of a Land Grant university leads to seven additional non-employer establishments in animal support services (1152). Other notable findings include the local foods movement's effect on non-employers in the agricultural supply chain, and the different locational determinants between employers and non-employers. In general, non-employer establishments prefer to locate in counties with more farms and tend to serve more rural markets, implying that this establishment type may represent lower-ordered service in Christaller's (1966) functional hierarchy of central place theory.

While there are limitations to this research, this article represents a first look into how restricted-access data and central place theory may be used to model establishments' location decisions. For this reason, we note two limitations that should be considered in future research. First, zero-inflation models that can handle panel data should be developed to provide stronger arguments for the exogeneity of independent variables and obtain a better view of how the agricultural supply chain has changed over time. Second, given the empirical nature of this research and its strong implications for industry and rural economic development outreach, the analysis should be extended to include other industries within, and outside of FAI.

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Appendix

Table A1. Agricultural Production Summary Statistics

Variable	Counties	Mean	Std. Dev.	Max
Local Foods Farms	2,557	118.58	123.48	1,484
Dairy Farms	2,499	25.63	68.43	1,878
Sheep and Goat Farms	2,672	43.06	50.31	765
Produce Farms	418	188.97	390.19	4,207
Chicken Broiler Farms	2,367	13.90	25.78	553
Chicken Layer Farms	2,630	11.78	14.54	367
Hog Farms	2,819	19.76	25.59	441
Cattle Farms	3,046	238.55	249.59	2,186
Soy Farms	2,159	139.57	173.37	1,056
Cotton Farms	635	57.18	86.27	680
Grain Farms	2,920	172.35	214.24	3,054
Peanut Farms	244	10.25	14.34	89

Source: Public data from National Agricultural Statistics Service – Quick Stats

Table A2. Marginal Effects for Locational Determinants of FAI

Industry	Support Activities for Crop Production		Support Activities for Animal Production		Animal Slaughtering and Processing	
Establishment Type	Non-Emp. Est.	Emp. Est.	Non-Emp. Est.	Emp. Est.	Non-Emp. Est.	Emp. Est.
Sheep & Goat Farms			**2.715****	0.2041	0.1655	0.0268
Hog Farms			**13.11****	**0.5176***	**-0.2233***	**0.4479*****
Cattle Farms			**1.896****	**0.1347*****	**0.0689****	**0.1154*****
Broiler Farms			**8.47****	**0.631***	**0.2108****	**0.6331*****
Lay Farms			-0.6038	0.2622		
Dairy Farms			4.275	**0.662****	0.0826	0.0156
Produce Farms	0.5997	**0.4817****				
Grain Farms	**4.934*****	**1.489*****				
Soy Farms	**2.204*****	0.1936				
Peanut Farms	**46.28*****	4.736				
Cotton Farms	**10.45*****	**4.104*****				
Local Foods Farms	**3.681*****	0.2095	**1.136***	**0.3317*****	0.1215	**-0.0555***
ISP count	-0.3544	**0.2265***	**-0.7966***	0.01	0.0207	0.0127
Social Capital Index	**1.762****	**0.7114*****	0.6186	0.0909	**0.0445****	**0.2147*****
Land Grant	0.998	0.2201	**7.402***	**0.6114***	(D)	**-0.3027****
Railroad Establishments	-1.907	1.691	0.7667	-0.1334	0.0248	**0.1258***
Trucking Employment	0.0723	**0.025***	-0.0508	-0.0045	**0.0087*****	**0.0089*****
Air Freight Establishments	0.8998	**-1.014***	5.987	0.4049	-0.0117	-0.0184
Interstate Per 100 sq. mi.	3.341	**4.163****	3.198	0.0487	-0.0048	0.1017
(Interstate Per 100 sq. mi.)^2	**-0.6112****	**-0.4698****	-0.5566	-0.0232	-0.0004	-0.0049
Highway Per 100sq. mi.	-0.1286	**-0.8371*****	0.1348	**0.15****	**-0.057****	0.0289
(Highway Per 100sq. mi.)^2	-34.72	11.07	-9.002	**-6.846****	1.816	0.025
Metro Adjacent	-1.012	0.4078	0.486	0.1526	(D)	0.0254
Metro	**-3.209****	-0.0294	0.0305	**0.5105****	-0.1025	-0.0866
Poverty	**0.6337*****	0.05	-0.0656	**-0.0348****	0.0023	**0.0184****
Ln(Population)	**12.56*****	**0.9768*****	**10.78****	**0.9055*****	**0.3587*****	**0.621*****
Population Density	0.0369	-0.039	**-0.3607***	**-0.0648*****	**0.0327*****	0.0149
Highschool	-1.369	-1.315	2.572	-0.3226	0.0477	0.2531
Bachelors	-8.018	-1.122	**36.52***	**8.174*****	-0.5781	**-2.725*****
Median Age	0.0044	0.0167	**0.3234***	**0.0314***	-0.0053	-0.0065
Unemployment	**-0.9126****	-0.0665	**-1.904****	**-0.2374*****	-0.0074	**-0.0984*****
Per Capita Income	**20.22****	4.206*	**10.51***	2.278***	**-0.7508*****	-0.1858

Hispanic	**40.19*** **	**15.89*** **	**20.96** **	**3.434*** **	**-0.618** **	**0.9953*** **
White	**0.2268*** **	-0.0065	0.0704	-0.0092	0.005	0.0067
Asian	**-0.4589***	-0.0204	**-0.5324***	**-0.0773** **	-0.0035	**0.0255** **
Black	-0.0614	0.0241	-0.0732	-0.0008	0.0044	**0.0178*** **
LQ-Manufacturing	**0.5293** **	-0.1203	0.2597	**0.1137*** **	**0.0511*** **	**0.1755*** **
LQ-Wholesale	**3.941*** **	**0.8099*** **	0.2799	0.0929	0.0001	**0.054** **
LQ-Transportation	**-0.5843***	**-0.3121** **	-0.1207	0.0132	0.0033	-0.0159
Median Home Value		-0.0011		-0.0003	-0.0007	-0.0012
Property Tax Rate		-0.0175		**0.0324** **	-0.0002	**0.0725*** **
Inflation Stage						
Sheep & Goat Farms				**-0.1542** **	0.0565	0.0159
Hog Farms				**0.0907*** **	-0.0183	-0.0564
Cattle Farms				**-0.0468*** **	**-0.1014***	**-0.0841** **
Dairy Farms				**-1.03*** **	0.0264	-0.0028
Broiler Farms					**0.1096*** **	0.0011
Produce Farms		-0.0664				
Grain Farms		**-0.3021*** **				
Soy Farms		0.0558				
Peanut Farms		-1.946				
Cotton Farms		**-0.8882*** **				
Local Foods Farms		**-0.0539*** **		**-0.2394*** **	-0.2252	0.0075
Highway Per 100sq. mi.		**0.0216***		0.0095	-0.0131	0.02
(Highway Per 100sq. mi.)2		-1.868		**-1.05** **	-0.8079	-1.826
Metro Adjacent		**0.0917*** **		**0.0571***	(D)	0.0722
Metro		**0.0836*** **		0.0321	**-0.0882** **	0.0815
Ln(Population)		**-0.044*** **		**-0.0122** **	-0.0024	-0.0167
High School		-0.0614		-0.0126	0.0357	0.0364
Bachelors		-0.3043		**0.0567**	0.1456	-0.7709
LQ-Wholesale		**0.0144** **		0.004	0.005	-0.0149
LQ-Manufacturing		0.0054		**-0.0025**	-0.0036	**-0.0751** **
LQ-Transportation		-0.0092		**0.0232*** **	0.002	-0.0027
Median Home Value		0.0006		0.0005	0.0015	0.0015
Property Tax Rate		0.0096		**-0.0556** **	0.0005	**-0.0934*** **

Significance levels: ***<1%, **<5%, *<10%
(D) cell did not meet disclosure requirements

Table A2. (continued) Marginal Effects for Locational Determinants of FAI

Industry	Fruit & Vegetable Manufacturing		Fruit & Vegetable Wholesalers	Equipment Wholesale	Farm Supply Wholesale		Nursery/ Farm Supply Stores
Establishment Type	Non-Emp. Est.	Emp. Est.	Emp. Est.	Emp. Est.	Non-Emp. Est.	Emp. Est.	Emp. Est.
Sheep & Goat Farms				-0.0445			
Hog Farms				-0.1738			
Cattle Farms				**0.0817*** **	**0.0807*** **	**0.0493***	
Broiler Farms				**0.5346*** **	0.3964	-0.5085	
Lay Farms				-0.4721	-0.1713		
Dairy Farms				0.4463	-0.0523	**-0.5173****	
Produce Farms	-0.0002	**0.1275*** **	0.297	**0.056****	0.0344	0.1165	-0.0237
Grain Farms				**0.5513*** **	**0.1571*** **	**0.8387*** **	0.1492
Soy Farms				-0.0477			-0.109
Peanut Farms				1.068	1.665	2.356	**2.215***
Cotton Farms				**0.7493*** **	0.0471	**1.188*** **	0.1322
Local Foods Farms	**0.203*** **	**0.029***	0.0205	-0.0202	**0.0356***	**0.1124****	**0.3599*** **
ISP count	-0.0356	0.0307	-0.0578	0.001	0.0327	**0.1656*** **	-0.066
Social Capital Index	-0.0255	0.0192	**0.3755*** **	**0.3052*** **	-0.0447	**0.2279*** **	**0.3412*** **
Land Grant	-0.0268	-0.1097	-0.3695	0.136	0.1033	-0.028	-0.2995
Railroad Establishments	0.0236	0.0482	0.0656	**0.1674***	-0.0118	0.3622	0.1163
Trucking Employment	0.0047	0.0012	0.003	0.0009	**0.004*** **	**0.012****	0.0025
Air Freight Establishments	0.0074	0.0155	0.1248	**0.1764***	**0.0879***	0.1255	0.0816
Interstate Per 100 sq. mi.	**-0.6938*** **	0.0183	**0.7659***	-0.1534	0.0242	-0.1388	-0.5134
(Interstate Per 100 sq. mi.)^2	**0.0155*** **	0.0006	**-0.0465****	**0.0199***	-0.006	-0.0126	0.0008
Highway Per 100sq. mi.	-0.0307	-0.0028	-0.0047	0.0255	-0.014	0.0891	0.0474
(Highway Per 100sq. mi.)^2	2.033	1.413	-2.232	**-10.79***	0.433	**-6.627****	-4.197
Metro Adjacent	**-0.3067***	-0.0002	-0.3049	0.068	-0.0742	**-0.2274***	0.1336
Metro	**-0.5666*** **	-0.1123	-0.0749	**-0.3624*** **	**-0.1479***	**-0.4156****	**-0.6708*** **
Poverty	**0.0226****	**0.0191*** **	**0.1124*** **	0.0127	-0.0014	0.0078	0.0213
Ln(Population)	**1.025*** **	**0.3897*** **	**1.487*** **	**1.403*** **	**0.3528*** **	**0.9548*** **	**3.335*** **
Population Density	**0.0323***	0.0071	0.0217	-0.0373	**0.0257****	-0.0002	**-0.1403*** **
Highschool	-0.1809	-0.3189	0.5102	0.3501	0.0024	**-1.286****	**-1.301****
Bachelors	**6.904*** **	**1.459***	3.854	**-2.449***	0.4006	-0.4121	-0.4783
Median Age	**0.0429*** **	**0.0169*** **	0.0343	**-0.0294****	0.008	-0.0047	**0.0669*** **
Unemployment	0.0197	0.017	0.0008	**-0.1029*** **	-0.0026	-0.0522	**-0.1744*** **
Per Capita Income	**-1.013****	0.1483	0.2872	**1.754*** **	0.0032	**2.094*** **	**2.903*** **
Hispanic	**1.831*** **	**1.344*** **	**5.542*** **	**2.415*** **	**0.5717*** **	**3.737*** **	**-1.036***
White	**0.0224*** **	0.0034	0.0044	**0.023*** **	**0.0113****	**0.0173***	**0.0247****

Asian	0.0227	-0.0022	0.0265	-0.0325	-0.0039	-0.0249	**-0.0694***
Black	**0.027***	0.0003	0.0068	0.0144	**0.0105**	**0.0376***	0.005
LQ-Manufacturing	-0.0274	**0.0702***	**-0.1288***	**0.0988***	0.0213	**0.1093***	**0.155***
LQ-Wholesale	-0.0318	**0.0983***	**0.8404***	**0.5598***	**0.0518**	**0.5503***	**0.2482***
LQ-Transportation	**-0.084***	0.0334	0.0154	0.0114	-0.0112	-0.0439	0.071
Median Home Value	0.0055	0.0056	**0.0084**	**-0.004**	0.0006	-0.0011	
Property Tax Rate	**0.0609**	-0.0176	**0.0877***	**-0.0748**	0.0155	0.0259	
Inflation Stage							
Sheep & Goat Farms				0.0305			
Hog Farms				0.1192			
Cattle Farms				**-0.0186***	**-0.0823***	**-0.0208**	
Dairy Farms				-0.3059	0.0379	-0.135	
Broiler Farms				**-0.1505**	-0.5793	**0.099**	
Lay Farms				-0.3851	0.245		
Produce Farms	0.0093	**-0.2393***	-0.6546	-0.0108	-0.0398	-0.0333	
Grain Farms				**-0.1771***	**-0.0977***	**-0.1859***	
Soy Farms				0.0327			
Peanut Farms				**-0.4831***	-2.445	-0.6435	
Cotton Farms				**-0.1678**	-0.0049	**-0.2903***	
Local Foods Farms	**-0.113***	-0.0314	**-0.0835***	-0.0176	0.0049	-0.0058	
Highway Per 100sq. mi.	**-0.0435**	0.0515	-0.0132	-0.0039	**-0.0213***	-0.0046	
(Highway Per 100sq. mi.)2	**2.172***	-7.129	1.444	-0.0375	0.4268	-0.1529	
Metro Adjacent	**-0.0906***	-0.0218	-0.0763	0.0282	0.0065	-0.0244	
Metro	-0.384	-0.0139	0.0584	0.034	-0.0046	-0.0359	
Ln(Population)	-0.0018	**-0.1026***	**-0.137***	**-0.0519***	-0.0245	**-0.0366***	
High School	0.0663	**-0.5289**	**0.6305***	0.0634	0.1374	0.1214	
Bachelors	0.6437	**-1.463***	**1.93***	-0.3511	-0.2994	-0.3522	
LQ-Wholesale	-0.0084	0.0014	**0.0357***	**-0.057**	-0.0146	**-0.0741**	
LQ-Manufacturing	-0.0507	-0.0298	-0.0017	-0.0022	0.0148	0.0028	
LQ-Transportation	-0.0074	-0.0045	0.0144	0.0089	0.0088	0.0023	
Median Home Value	**-0.0107***	-0.0119	**-0.0207**	**0.0028**	-0.0008	0.0008	
Property Tax Rate	**-0.1186**	0.0376	**-0.2173***	**0.0512**	-0.0222	-0.0195	

Significance levels: ***<1%, **<5%, *<10%
(D) cell did not meet disclosure requirements